USB-7204

12-Bit, 50 kS/s, Multifunction DAQ Board

User's Guide

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About this User's Guide

This document describes the Measurement Computing USB-7204 data acquisition device and lists device specifications.

Conventions

For more information

Text presented in a box signifies additional information related to the subject matter.

Caution! Shaded caution statements present information to help you avoid injuring yourself and others, damaging your hardware, or losing your data.

bold text — **Bold** text is used for the names of objects on a screen, such as buttons, text boxes, and check boxes.

italic text — *Italic* text is used for the names of manuals and help topic titles, and to emphasize a word or phrase.

Where to find more information

Additional information about USB-7204 hardware is available on our website at www.mccdaq.com. You can also contact Measurement Computing Corporation with specific questions.

- Knowledgebase: kb.mccdaq.com
- Phone: 508-946-5100 and follow the instructions for reaching Tech Support
- Fax: 508-946-9500 to the attention of Tech Support
- Email: techsupport@mccdaq.com

Introducing the USB-7204

The USB-7204 is a USB 2.0 full-speed device that is supported under the following operating systems:

- Microsoft Windows 8/7/Vista/XP (32-bit or 64-bit)
- Android 3.1 or later
- Macintosh (32-bit or 64-bit)
- Linux (32-bit or 64-bit)

The USB-7204 is compatible with both USB 1.1 and USB 2.0 ports.

The device that provides the following features:

- Eight channels of 16-bit analog input configurable for eight 11-bit single-ended inputs (represented as 12-bit data — even values only) or four 12-bit differential inputs.
- Two 12-bit analog outputs
- 16 individually configurable digital I/O channels
- 32-bit event counter
- Digital trigger input
- Bidirectional SYNC pin for external clocking and synchronization with another board

The device is powered by the +5 volt USB supply from your computer, and requires no external power.

USB-7204 block diagram

USB-7204 functions are illustrated in the block diagram shown here.

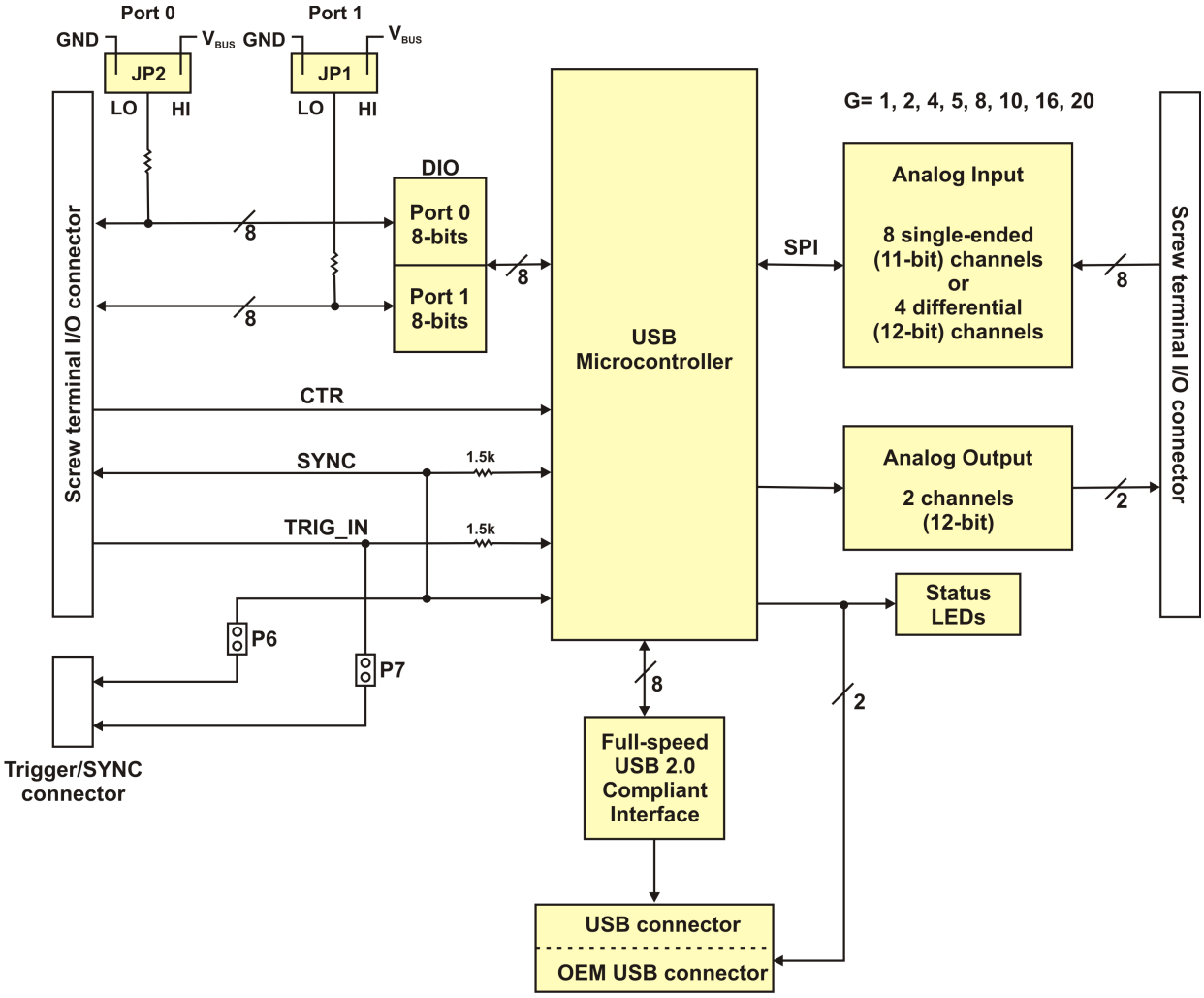


Figure 1. USB-7204 functional block diagram

Installing the USB-7204

What comes with your shipment?

The following items are shipped with the USB-7204:

Hardware

- USB-7204
- USB cable

Optional hardware

OEM connector cable

Documentation

MCC DAQ Quick Start Guide

The Quick Start Guide booklet provides an overview of the MCC DAQ software you received with the device, and includes information about installing the software. Please read this booklet completely before installing any software or hardware.

Insert

The operating systems that are supported by the device are listed on the insert, and includes the internet location where you can download DAQFlex software, and the locations where you can learn more about DAQFlex software and MCC DAQ software.

Unpacking the USB-7204

As with any electronic device, you should take care while handling to avoid damage from static electricity. Before removing the USB-7204 from its packaging, ground yourself using a wrist strap or by simply touching the computer chassis or other grounded object to eliminate any stored static charge.

If any components are missing or damaged, contact us immediately using one of the following methods:

- Knowledgebase: kb.mccdaq.com
- Phone: 508-946-5100 and follow the instructions for reaching Tech Support
- Fax: 508-946-9500 to the attention of Tech Support
- Email: techsupport@mccdaq.com

For international customers, contact your local distributor. Refer to the International Distributors section on our website at www.mccdaq.com/International.

Installing the software

Note: Before installing the USB-7204 hardware, you must install the software you plan to use with the device.

The USB-7204 is supported by DAQFlex software and Universal Library software. You can install both software packages on your computer.

DAQFlex

Install DAQFlex software when you want to develop data acquisition applications that can be deployed across multiple operating systems and custom embedded systems.

DAQFlex software for each supported operating system is available from the DAQFlex download page at www.mccdaq.com/DAQFlexDL. Refer to the *DAQFlex Software User's Guide* at www.mccdaq.com/pdfs/manuals/DAQFlex%20Software.pdf for instructions about how to install DAQFlex software.

Universal Library and InstaCal

Installing in a Windows environment

Refer to the *Quick Start Guide* that ships with your device for instructions on installing the MCC DAQ software in a Windows environment. This booklet is available in PDF at www.mccdaq.com/PDFmanuals/DAQ-Software-Quick-Start.pdf.

Running and deploying apps in an Android environment

For instructions on deploying and running apps in an Android environment, refer to the *UL for Android Example Projects* topic in the *Universal Library for Android Help* that installs with the UL for Android software library on the MCC DAQ CD.

Installing the hardware

Install the software before you install your device

A driver needed to run the USB-7204 is installed when you install the software. Therefore, you need to install the software package you plan to use before you install the hardware.

For operation on a Windows operating system, we recommend that you run Windows Update to update your operating system with the latest USB drivers.

There are two ways to connect the USB-7204 to your system:

- Connect a USB cable from the **USB** connector to either a USB port on the computer or to an external USB hub connected to the computer. No external power is required.

or

- Use a 2.54 mm (0.1 in.) box header to connect with the OEM connector. The connector pinout is shown below:

Pin	Signal Name	Pin	Signal Name
1	N/C	2	VBUS
3	N/C	4	D–
5	N/C (do not connect anything to this pin)	6	D+
7	N/C (do not connect anything to this pin)	8	GND
9	N/C (do not connect anything to this pin)	10	SHIELD

When you connect the USB-7204 for the first time on a computer running Windows, a **Found New Hardware** message opens as the device is detected. The installation is complete when the message closes.

After the USB-7204 is installed, the **Power** LED remains on to indicate that communication is established between the USB-7204 and your computer.

Caution! Do not disconnect any device from the USB bus while the computer is communicating with the USB-7204, or you may lose data and/or your ability to communicate with the USB-7204.

If the Power LED turns off

If the **Power** LED is on but then turns off, the computer has lost communication with the USB-7204. To restore communication, disconnect the USB cable from the computer, and then reconnect it. This should restore communication, and the **Power** LED should turn on.

Programming and developing applications

You can program and develop applications for the USB-7204 using MCC DAQ software and DAQFlex software. OEM users can create a custom driver for use with the message-based firmware to interface with the device.

- Refer to the *Quick Start Guide* for information about the Universal Library and InstaCal.
- Refer to the DAQFlex Software User's Guide for information about DAQFlex software.
- Refer to the Message-based Firmware Specification for information about the message-based firmware.

Functional Details

Analog input acquisition modes

The USB-7204 can acquire analog input data in software paced and continuous scan modes.

Software paced mode

You can acquire one analog sample at a time in software paced mode. You initiate the A/D conversion by calling a software command. The analog value is converted to digital data and returned to the computer. You can repeat this procedure for each channel desired until you have the total number of samples that you want from each channel. The maximum throughput sample rate in software paced mode is system-dependent.

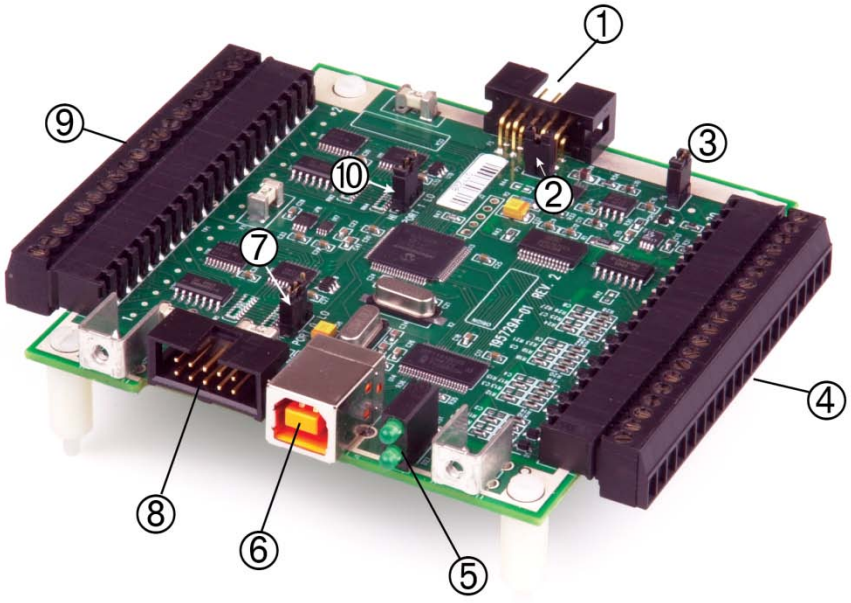
Continuous scan mode

You can acquire data from up to eight channels simultaneously in continuous scan mode. The analog data is continuously acquired and converted to digital values until you stop the scan. Data is transferred in blocks of up to 32 samples from the USB-7204 to the memory buffer on your computer.

The maximum continuous scan rate of 50 kS/s is an aggregate rate. You can acquire data from one channel at 50 kS/s, two channels at 25 kS/s, and four channels at 12.5 kS/s. You can start a continuous scan with either a software command or with an external hardware trigger event.

Components

The USB-7204 components are shown in Figure 2.



1	Trigger/Sync connector	5	Power LED (top) and Status LED (bottom)	8	OEM connector
2	Trigger jumper (P7)	6	USB connector	9	Pins 21-40
3	Sync jumper (P6)	7	Pull-up/down jumper JP2 (Port 0)	10	Pull-up/down jumper JP1 (Port 1)
4	Pins 1-20				

Figure 2. USB-7204 components

USB connector

The USB connector provides +5 V power and communication. The voltage supplied through the USB connector is system-dependent, and may be less than 5 V. No external power supply is required.

This connector operates in parallel with the OEM connector — do not connect to both the USB connector and the OEM connector.

OEM connector

The OEM connector operates in parallel with the USB connector — do not connect to both the USB connector and the OEM connector.

The OEM connector is a 0.1" box header. Pins 2, 4, 6, 8, and 10 provide a USB connection, as listed in the connector pinout below:

OEM connector pinout

Pin	Signal Name	Pin	Signal Name
1	N/C	2	VBUS
3	N/C	4	D–
5	N/C (do not connect anything to this pin)	6	D+
7	N/C (do not connect anything to this pin)	8	GND
9	N/C (do not connect anything to this pin)	10	SHIELD

Modifications are required in order to use the OEM connector

We recommend that you return the device to the factory for this modification.

Should you have the capabilities to perform the modifications, the following change is required: to create a USB connection via the OEM connector, locations R48 and R49 must be populated. We recommend that you populate with 0603 size 0 Ω resistors or provide solder bridges to close the gaps.

Trigger/Sync connector

The Trigger/Sync connector provides two signals — **SYNC** and **TRIG_IN**. These signals are also available on the screw terminal (see page 16 for details about these signals).

Trigger/Sync connector pinout

Pin	Signal Name	Pin	Signal Name
1	TRIG_IN	2	GND
3	N/C	4	GND
5	SYNC	6	GND
7	N/C	8	GND
9	N/C	10	N/CD

Use a 0.1" box header when making connections to the Trigger/Sync connector.

The Trigger/Sync connector internally connects its SYNC and TRIG_IN pins to the screw terminal via jumpers **P6** and **P7**.

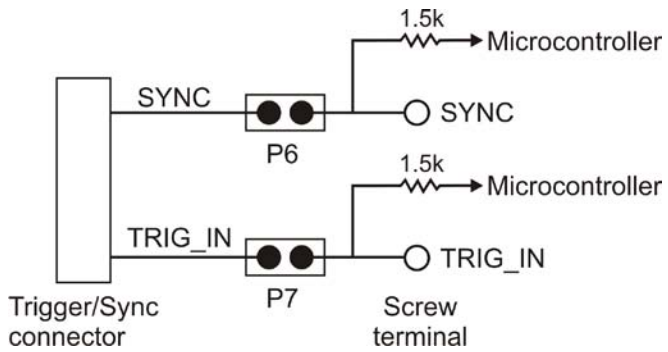


Figure 3. Jumper P6 and P7 schematic

Sync jumper (P6)

The Sync jumper internally connects the SYNC pin on the Trigger/Sync connector to the SYNC pin on the screw terminal. Remove this jumper on boards that will not send/receive the SYNC signal through the SYNC/TRIG connector. Refer to Figure 2 on page 10 for the location of this jumper.

Trigger jumper (P7)

The Trigger jumper internally connects the TRIG_IN pin on the Trigger/Sync connector to the TRIG_IN pin on the screw terminal. Remove this jumper on boards that will not send/receive the TRIG signal through the SYNC/TRIG connector. Refer to Refer to Figure 2 on page 10 for the location of this jumper.

USB connector

The USB connector provides +5 V power and communication. The voltage supplied through the USB connector is system-dependent, and may be less than 5 V. No external power supply is required.

This connector operates in parallel with the OEM connector — do not connect to both the USB connector and the OEM connector.

LED indicators

The USB-7204 has LEDs for power and communication status. See Figure 2 for the location of each LED.

LED type	Indication
Power	Steady green: The device's microcontroller is connected to a computer or external USB hub.
Status	Blinking green: data is being transferred over the USB bus.

Screw terminals

The screw terminals provide the following connections:

- Eight analog input connections (**CH0 IN** to **CH7 IN**)
- Two analog output connections (**D/A OUT 0** to **D/A OUT 1**)
- One external trigger source (**TRIG_IN**)
- One SYNC terminal for external clocking and multi-unit synchronization (**SYNC**)
- One external event counter connection (**CTR**)
- Five analog ground connections (**AGND**)
- One ground connection (**GND**)
- 16 digital I/O connections (**Port 0 Bit 0** to **Port 0 Bit 7**, and **Port 1 Bit 0** to **Port 1 Bit 7**)
- One output power connection (**+5V**$_{USER}$)
- Three ground connections (**GND**)

Screw terminal connections are shown in Figure 4.

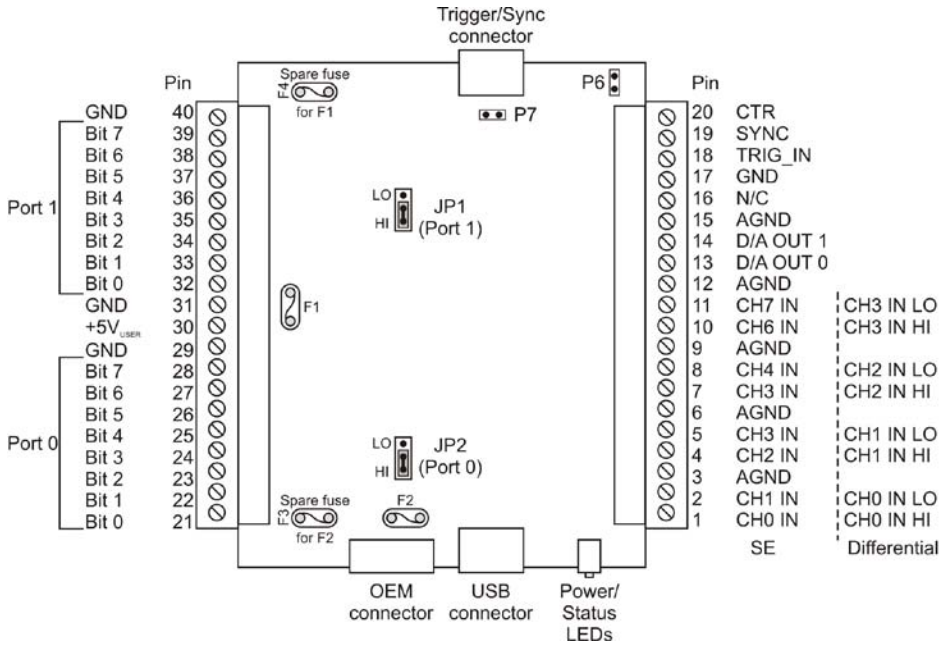


Figure 4. Screw terminal pinout

Signal connections

Analog input

You can connect up to eight analog input connections to the screw terminal containing pins 1 to 20 (**CH0 IN** through **CH7 IN**.) Refer to Figure 4 above for the location of the analog input pins.

You can configure the analog input channels as eight single-ended channels or four differential channels. By default, differential mode is configured at power-up.

Single-ended configuration

When configured for single-ended mode, each analog input has 11-bit resolution, due to restrictions imposed by the A/D converter. With single-ended mode, the input signal is referenced to signal ground and delivered through two wires:

- The wire carrying the signal to be measured connects to CH# IN.
- The second wire connects to AGND.

The input range for single-ended mode is ±10 V.

Single-ended measurements using differential channels

To perform a SE measurement using differential channels, connect the signal to the "CH# IN HI" input, and ground the associated "CH# IN LO" input.

Differential configuration

When configured for differential mode, each analog input has 12-bit resolution. In differential mode, the input signal is measured with respect to the low input and delivered through three wires:

- The wire carrying the signal to be measured connects to CH0 IN HI, CH1 IN HI, CH2 IN HI, or CH3 IN HI.
- The wire carrying the reference signal connects to CH0 IN LO, CH1 IN LO, CH2 IN LO, or CH3 IN LO.
- The third wire connects to GND.

A low-noise precision programmable gain amplifier (PGA) is available on differential channels to provide gains of up to 20 and a dynamic range of up to 12-bits. Differential mode input voltage ranges are ±20 V, ±10 V, ±5 V, ±4 V, ±2.5 V, ±2.0 V, ±1.25 V, and ±1.0 V.

In differential mode, the following two requirements must be met for linear operation:

- Any analog input must remain in the −10V to +20V range with respect to ground at all times.
- The maximum differential voltage on any given analog input pair must remain within the selected voltage range.

The input [*common-mode voltage* + *signal*] of the differential channel must be in the −10 V to +20 V range in order to yield a useful result. For example, you input a 4 V pp sine wave to CHHI, and apply the same sine wave 180° out of phase to CHLO. The common mode voltage is 0 V. The differential input voltage swings from 4 V-(-4 V) = 8 V to -4 V-4 V = -8V. Both inputs satisfy the -10 V to +20 V input range requirement, and the differential voltage is suited for the ±10 V input range (see Figure 5).

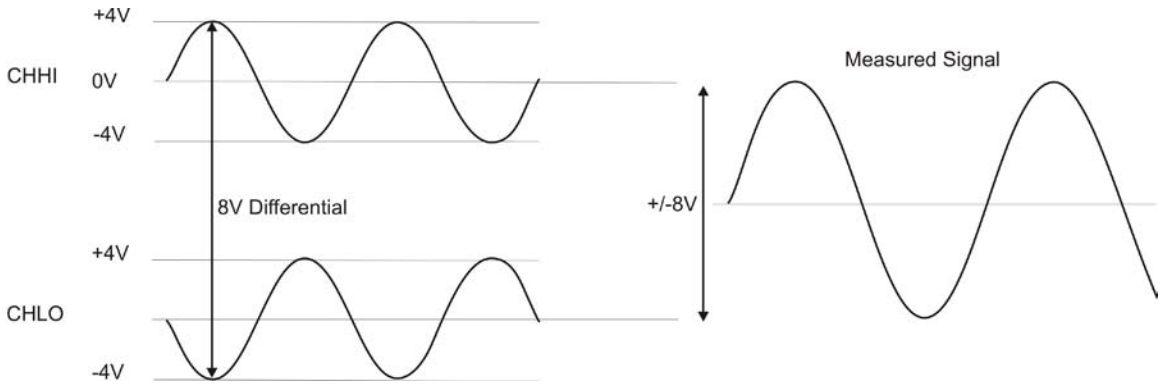


Figure 5. Differential voltage example: common mode voltage of 0 V

If you increase the common mode voltage to 11 V, the differential remains at ±8 V. Although the [*common-mode voltage* + *signal*] on each input now has a range of +7 V to +15 V, both inputs still satisfy the –10 V to +20 V input requirement (see Figure 6).

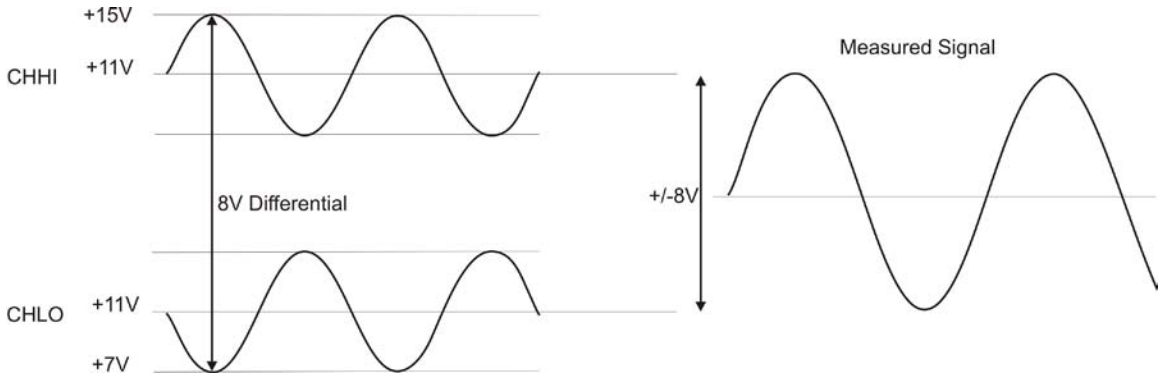


Figure 6. Differential voltage example: common mode voltage of 11 V

If you decrease the common-mode voltage to –7 V, the differential stays at ±8 V. However, the solution now violates the input range condition of -10 V to +20 V. The voltage on each analog input now swings from –3 V to –11 V. Voltages between –10 V and –3 V are resolved, but those below –10 V are clipped (see Figure 7).

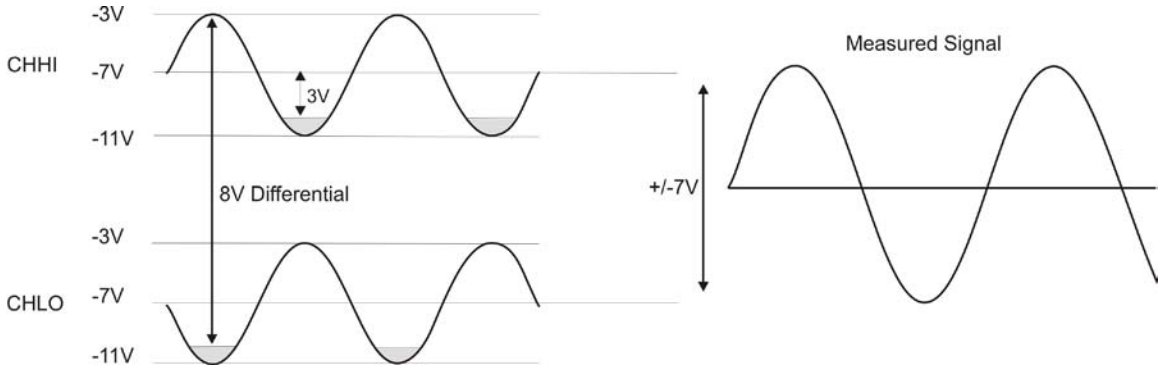


Figure 7. Differential voltage example: common mode voltage of –7 V

Since the analog inputs are restricted to a −10 V to +20 V signal swing with respect to ground, all ranges *except* ±20 V can realize a linear output for any differential signal with zero common mode voltage and full scale signal inputs. The ±20 V range is the exception. You cannot put −20 V on CHHI and 0 V on CHLO since this violates the input range criteria.

The table below shows some possible inputs and the expected results.

Sample inputs and differential results

CHHI	CHLO	Result
–20 V	0 V	Invalid
–15 V	+5 V	Invalid
–10 V	0 V	–10 V
–10 V	+10 V	–20 V
0 V	+10 V	–10 V
0 V	+20 V	-20 V
+10 V	–10 V	+20 V
+10 V	0 V	+10 V
+15 V	–5 V	+20 V
+20 V	0	+20 V

Analog output

You can connect up to two analog output connections to screw terminal pins 13 and 14 (**D/A OUT 0** and **D/A OUT 1**). Each channel can be paced individually at rates up to 10,000 updates per second. Both channels can be paced simultaneously using the same time base at 5000 updates per channel. The 0-4.096 V output range provides a convenient 1 mV per LSB when setting the output voltage levels.

Digital I/O

The USB-7204 has two eight-bit ports (**Port 0** to **Bit 0** to **Bit 7** and **Port 1** to **Bit 0** to **Bit 7**). Each port is configurable as either input or output.

Pull up/down configuration

The digital pins are configurable via jumpers for pull-up to USB +5 V (HI) or pull-down to ground (LO). Jumper JP2 configures Port 0, and JP1 configures Port 1. On power up and reset the DIO pins are configured as input and pulled by JP1/JP2.

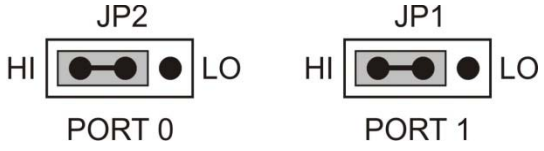


Figure 8. Jumper JP0 and JP1 configuration

When configured for input, the digital I/O terminals can be used to detect the state of any TTL level input.

For more information on digital signal connections

For more information on digital signal connections and digital I/O techniques, refer to the *Guide to DAQ Signal Connections* (available on our web site at www.mccdaq.com/signals/signals.pdf).

Trigger input

The digital trigger input (**TRIG_IN**) lets you start an acquisition when a signal's rising or falling edge is detected. This pin is internally connected to the TRIG_IN pin on the Trigger/Sync connector (see page 11).

SYNC I/O

The **SYNC** terminal is a bidirectional I/O signal that can be configured as an input or an output (default):

- Configure as an external clock input to externally pace the A/D conversions from an external source or another USB-7204. The SYNC terminal supports TTL-level input signals of up to 50 kHz.

  When used as a clock input, the SYNC pin operates in one of two modes – slave or gated slave.

  - In slave mode, the USB-7204 ignores the first clock pulse in order to ensure adequate setup time. Use this mode when the USB-7204 is being paced from a continuous clock source, such as a generator.
  - In gated slave mode, it is assumed that the clock signal is held off for an adequate amount of time for setup to occur. No clock pulses are ignored. Use this mode when the source of the external clock is another USB-7204.
- Configure as an output to pace the conversions on another USB-7204.

  When configured as an output, the internal A/D pacer clock is sent to the screw terminal. You can use this signal as a clock input to a second USB-7204 by connecting it to the SYNC pin and Trig/SYNC connector of the second device.

The **SYNC** pin is internally connected to the SYNC pin on the Trigger/Sync connector (see page 11).

Counter input

The **CTR** connection is a TTL-level input to a 32-bit event counter. Refer to Figure 4 on page 13 for the location of this pin. The internal counter increments when the TTL level transitions from low to high. The counter can count frequencies of up to 1 MHz.

Power output

The **+5VUSER output** connection is a 5 volt output that is supplied by the host computer.

Caution! Do not connect to an external power supply to this terminal or you may damage the USB-7204 and possibly the computer.

The maximum total output current that can be drawn from all USB-7204 connections (power, analog and digital outputs) is 420 mA. This maximum applies to most personal computers and self-powered USB hubs. Bus-powered hubs and notebook computers may limit the maximum available output current to 100 mA.

Just connecting the USB-7204 to your computer draws 80 mA of current from the USB +5 V supply. Once you start running applications with the USB-7204, each DIO bit can draw up to 2.5 mA, and each analog output can draw 15 mA. The maximum amount of +5 V current available for experimental use, over and above that required by the USB-7204, is the difference between the *total current requirement* of the USB (based on the application) and the *allowed current draw* of the computer platform (500 mA for desktop computers and self-powered hubs, or 100 mA for bus-powered hubs and notebook computers). It shall not exceed 375 mA, based on the Slo-Blo Fuse current rating connected to the +5V terminal.

With all outputs at their maximum output current, you can calculate the total current requirement of the USB-7204 USB +5 V as follows:

(USB-7204 @ 80 mA) + (16 DIO @ 2.5 mA ea) + (2 AO @ 15 mA ea) = 150 mA

For an application running on a computer or powered hub, the maximum available excess current is 500 mA − 150 mA = 350 mA. This number is the total maximum available current at the **+5V$_{user}$ output** screw terminal. Measurement Computing highly recommends that you figure in a safety factor of 20% below this

maximum current loading for your applications. A conservative, safe user maximum in this case would be in the 350 mA to 375 mA range (fuse-rated).

Since laptop computers typically allow up to 100 mA, the USB-7204 in a fully-loaded configuration may be above that allowed by the computer. In this case, you must determine the per-pin loading in the application to ensure that the maximum loading criteria is met. The per-pin loading is calculated by simply dividing the +5 V by the load impedance of the pin in question.

Ground

The analog ground (**AGND**) terminals provide a common ground for all analog channels. The digital ground (**GND**) terminals provide a common ground for the digital, trigger, counter, and sync channels and the power terminal.

Accuracy

The overall accuracy of any instrument is limited by the error components within the system. Quite often, resolution is incorrectly used to quantify the performance of a measurement product. While "12-bits" or "1 part in 4096" does indicate what can be resolved, it provides little insight into the quality of an absolute measurement. Accuracy specifications describe the actual results that can be realized with a measurement device.

There are three types of errors which affect the accuracy of a measurement system:

- offset
- gain
- nonlinearity

The primary error sources in the USB-7204 are offset and gain. Nonlinearity is small in the USB-7204, and is not significant as an error source with respect to offset and gain.

Figure 9 shows an ideal, error-free, USB-7204 transfer function. The typical calibrated accuracy of the USB-7204 is range-dependent, as explained in the *Specifications* chapter on page 21. We use a ±10 V range here as an example of what you can expect when performing a measurement in this range.

The accuracy plots in Figure 9 are drawn for clarity and are not drawn to scale.

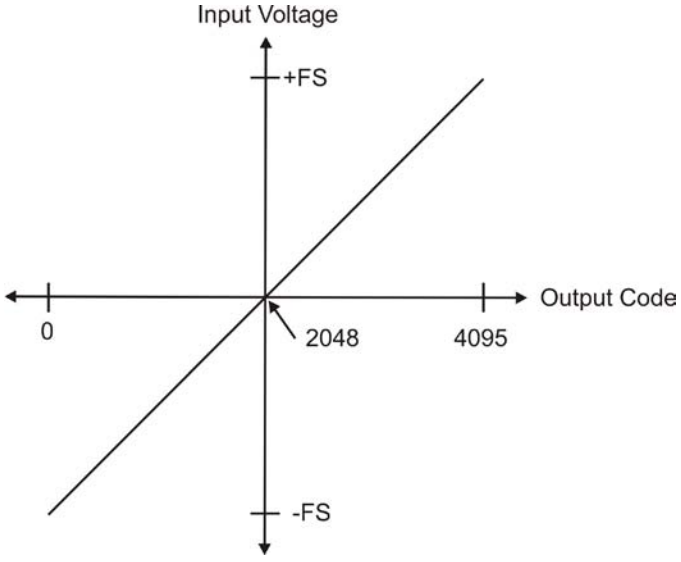


Figure 9. Ideal ADC transfer function

The USB-7204 offset error is measured at mid-scale. Ideally, a zero volt input should produce an output code of 2048. Any deviation from this is an offset error. Figure 10 shows the USB-7204 transfer function with an offset error. The typical offset error specification on the ±10 V range is ±9.77 mV. Offset error affects all codes equally by shifting the entire transfer function up or down along the input voltage axis.

The accuracy plots in Figure 10 are drawn for clarity and are not drawn to scale.

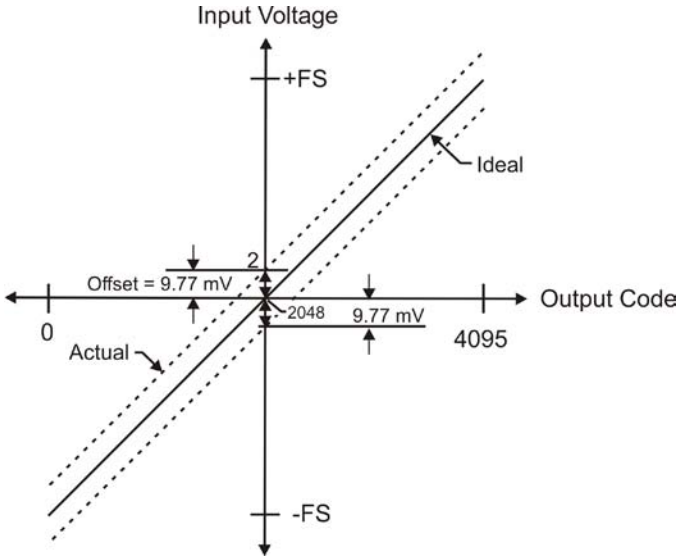


Figure 10. ADC transfer function with offset error

Gain error is a change in the slope of the transfer function from the ideal, and is typically expressed as a percentage of full-scale. Figure 11 shows the USB-7204 transfer function with gain error. Gain error is easily converted to voltage by multiplying the full-scale (**FS**) input by the error.

The accuracy plots in Figure 11 are drawn for clarity and are not drawn to scale.

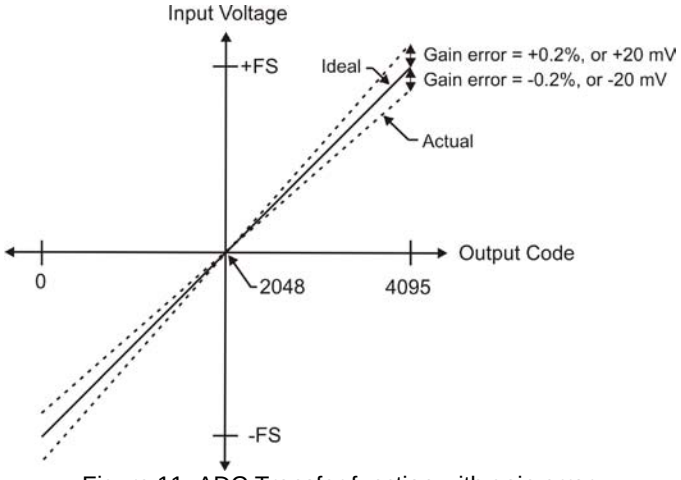


Figure 11. ADC Transfer function with gain error

For example, the USB-7204 exhibits a typical calibrated gain error of ±0.2% on all ranges. For the ±10 V range, this would yield 10 V × ±0.002 = ±20 mV. This means that at full scale, neglecting the effect of offset for the moment, the measurement would be within 20 mV of the actual value. Note that gain error is expressed as a ratio. Values near ±FS are more affected from an absolute voltage standpoint than are values near mid-scale, which see little or no voltage error.

Combining these two error sources in Figure 12, we have a plot of the error band of the USB-7204 for the ±10 V range. This is a graphical version of the typical accuracy specification of the product.

The accuracy plots in Figure 12 are drawn for clarity and are not drawn to scale

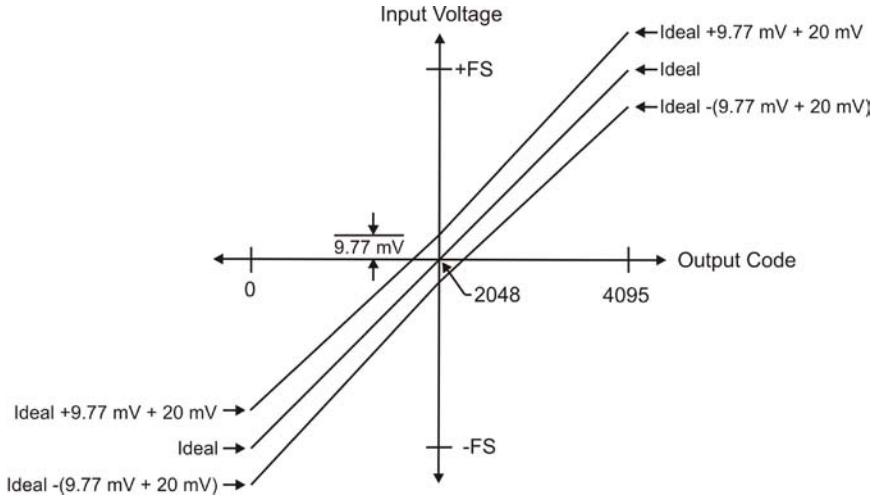


Figure 12. Error band plot

Channel gain queue

Use the device's channel gain queue to set up a scan sequence with a unique per-channel gain setting and channel sequence. The queue is large enough for up to 16 channel configurations limited to either single-ended or differential mode.

The channel gain queue feature removes the restriction of using an ascending channel sequence at a fixed gain. This feature creates a channel list which is written to local memory on the USB-7204. The channel list is made up of a channel number and range setting. An example of a four-element list is shown in the table below.

Sample channel gain queue list

Element	Channel	Range
0	CH0	BIP10V
1	CH0	BIP5V
2	CH7	BIP10V
3	CH2	BIP1V

When a scan begins with the gain queue enabled, the USB-7204 reads the first element, sets the appropriate channel number and range, and then acquires a sample. The properties of the next element are then retrieved, and another sample is acquired. This sequence continues until all elements in the gain queue have been selected. When the end of the channel list is detected, the sequence returns to the first element in the list.

This sequence repeats until the specified number of samples is gathered. You must carefully match the gain to the expected voltage range on the associated channel — otherwise, an over range condition can occur. Although this condition does not damage the USB-7204, it does produce a useless full-scale reading. It can also introduce a long recovery time from saturation, which can affect the next measurement in the queue.

Synchronized operations

You can connect the SYNC pin of two USB-7204 devices together in a master/slave configuration and acquire data from the analog inputs of both devices using one clock. When the SYNC pin is configured as an output, the internal A/D pacer clock is sent to the screw terminal. You can use this signal as a clock input to a second USB-7204 by connecting it to the SYNC pin and Trig/SYNC connector of the second device.

Mechanical drawing

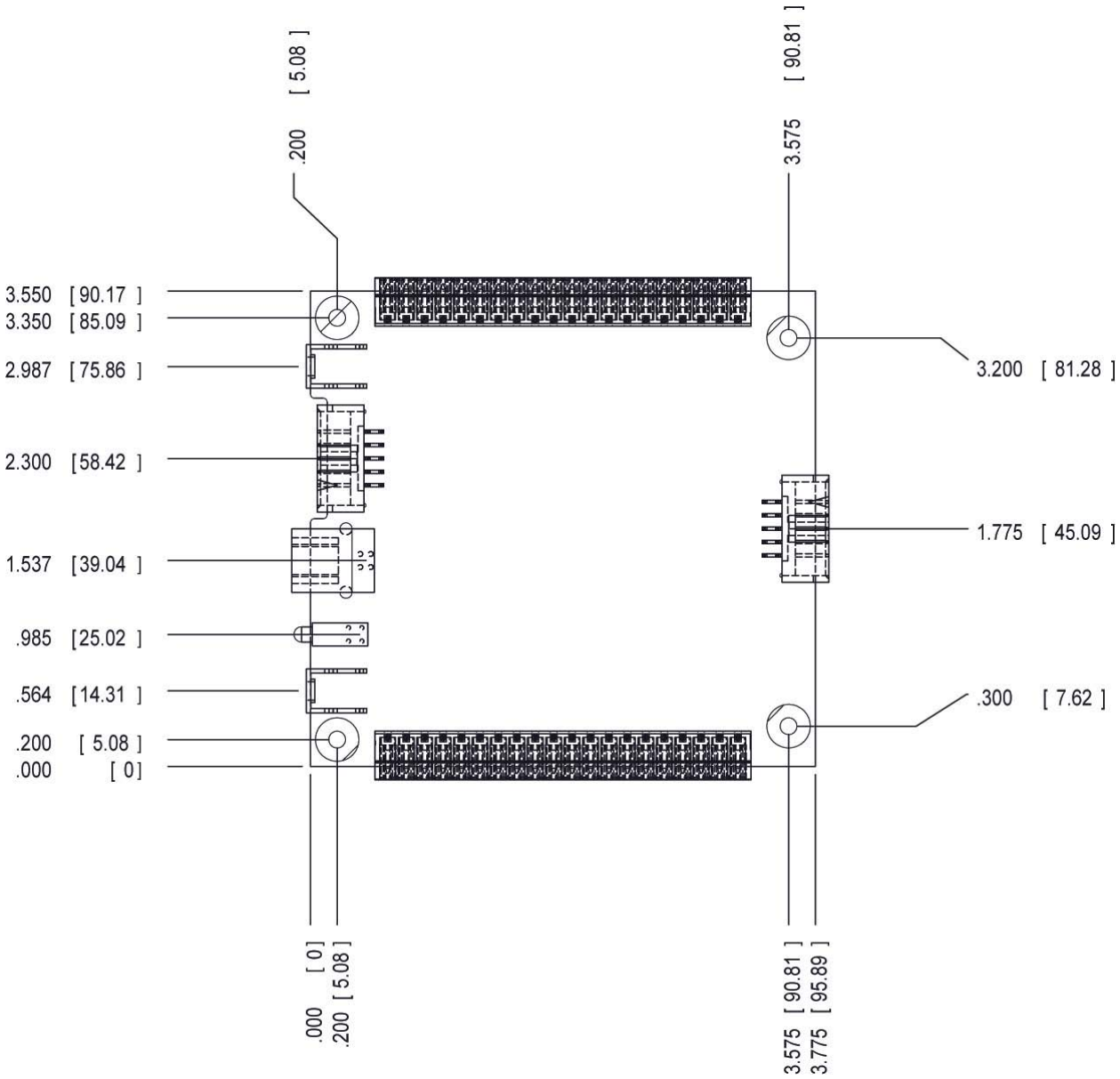


Figure 13. Circuit board dimension

Specifications

All specifications are subject to change without notice.
Typical for 25°C unless otherwise specified.
Specifications in *italic text* are guaranteed by design.

Analog input

Table 1. Analog input specifications

Parameter	Conditions	Specification
A/D converter type		Successive approximation type
Input modes		Single-ended or differential (default)
Input voltage range for linear operation, single-ended mode	CHx to GND	±10 volts (V) max
Input common-mode voltage range for linear operation, differential mode	CHx to GND	–10 V min, +20 V max
Absolute maximum input voltage	*CHx to GND*	*±28 V max*
Input impedance		*122 k*Ω
Input current (Note 1)	Vin = +10 V	70 microamperes (µA) typ
	Vin = 0 V	–12 µA typ
	Vin = –10 V	–94 µA typ
Number of channels		8 single-ended / 4 differential, software-selectable
Configuration		Single A/D
Sampling method		Multiplexed
Input ranges, single-ended mode		±10 V G=2
Input ranges, differential mode		±20 V G=1 ±10 V G=2 (default) ±5 V G=4 ±4 V G=5 ±2.5 V G=8 ±2.0 V G=10 ±1.25 V G=16 ±1.0 V G=20 Software-selectable
Throughput (Note 2)	Software paced	250 samples per second (S/s) typ, system dependent
	Scan to system memory	0.596 to 50,000 S/s
Channel gain queue	Up to 16 elements	Software-selectable channel, range.
Resolution (Note 3)	Differential	12 bits, no missing codes
	Single-ended	11 bits
Integral linearity error		±1 least significant bit (LSB) typ
Differential linearity error		±0.5 LSB typ
Repeatability		±1 LSB typ
Trigger source	Software-selectable	External digital: TRIG_IN
Pacer source	Software-selectable	■ Internal ■ External (SYNC), rising edge triggered ■ External Gated (SYNC), see Note 4 ■ Programmed IO
Calibration		Factory Cal factors stored in firmware. Cal factors must be applied via application software.

Note 1: Input current is a function of applied voltage on the analog input channels. For a given input voltage, V_{in}, the input leakage is approximately equal to ($8.181*V_{in}–12$) µA.

Note 2: Maximum throughput scanning to computer memory is machine dependent. The rates specified are for Windows XP only.

Note 3: The AD7870 converter only returns 11-bits (0-2047 codes) in single-ended mode and 12-bits in differential mode. Firmware versions prior to 2.04 have LSB justified data. Firmware versions from 2.04 on have MSB justified data.

Note 4: External Gated Sync holds off the first clock pulse after setting up a scan to ensure adequate setup time for the first conversion.

Table 2. Accuracy, differential mode

Range	Accuracy (LSB)
±20 V	5.1
±10 V	6.1
±5 V	8.1
±4 V	9.1
±2.5 V	12.1
±2 V	14.1
±1.25 V	20.1
±1 V	24.1

Table 3. Accuracy, single-ended mode

Range	Accuracy (LSB)
±10 V	4.0

Table 4. Accuracy components, differential mode - All values are (±)

Range	% of Reading	Gain Error at full scale (FS) (millivolts (mV))	Offset (mV)	Accuracy at FS (mV)
±20 V	0.2	40	9.766	49.766
±10 V	0.2	20	9.766	29.766
±5 V	0.2	10	9.766	19.766
±4 V	0.2	8	9.766	17.766
±2.5 V	0.2	5	9.766	14.766
±2 V	0.2	4	9.766	13.766
±1.25 V	0.2	2.5	9.766	12.266
±1 V	0.2	2	9.766	11.766

Table 5. Accuracy components, single-ended mode - All values are (±)

Range	% of Reading	Gain Error at FS (mV)	Offset (mV)	Accuracy at FS (mV)
±10 V	0.2	20	19.531	39.531

Table 6. Noise performance, differential mode

Range	Typical counts	Least significant bit$_{\text{root mean square}}$ (LSB_{rms})
±20 V	2	0.30
±10 V	2	0.30
±5 V	3	0.45
±4 V	3	0.45
±2.5 V	4	0.61
±2 V	5	0.76
±1.25 V	7	1.06
±1 V	8	1.21

Table 7. Noise performance, single-ended mode

Range	Typical Counts	LSB_{rms}
±10 V	2	0.30

Analog output

Table 8. Analog output specifications

Parameter	Conditions	Specification
Resolution		12-bits, 1 in 4096
Output range		*0 – 4.096 V, 1 mV per LSB.*
Number of channels		2
Throughput (Note 5)	Software paced	250 S/s single channel typ, system dependent
	Single channel, continuous scan	10 kS/s
	Dual channel, continuous scan, simultaneous update	5 kS/s
Power on and reset voltage		Initializes to 000h code
Output drive	Each D/A OUT	15 mA
Slew rate		0.8V/microsecond (µs) typ

Note 5: Maximum throughput scanning to computer memory is machine dependent. The rates specified are for Windows XP only. Maximum rates on operating systems that predate XP may be less and must be determined through testing on your machine.

Table 9. Analog output accuracy, all values are (±)

Range	Accuracy (LSB)
0 V to 4.096 V	4.0 typ, 45.0 max

Table 10. Analog output accuracy components, all values are (±)

Range	% of FSR	Gain Error at FS (mV)	Offset (mV) (Note 6)	Accuracy at FS (mV)
0 V to 4.096 V	0.1 typ, 0.9 max	4.0 typ, 36.0 max	1.0 typ, 9.0 max	4.0 typ, 45.0 max

Note 6: Negative offsets will result in a fixed zero-scale error or "dead band." At the max offset of 9 mV, any input code of less than 0x009 will not produce a response in the output.

Digital input/output

Table 11. Digital I/O specifications

Parameter	Specification
Digital type	CMOS
Number of I/O	16 (Port 0 bit 0 through bit 7, Port 1 bit 0through bit 7)
Configuration	2 banks of 8
Pull up/pull-down configuration	All pins configurable via jumpers (JP1 and JP2) to Vs or Ground via 47 k resistors. JP1 configures Port 1, and JP2 configures Port 0.
Input high voltage	2.0 V min, 5.5 V absolute max
Input low voltage	0.8 V max, –0.5 V absolute min
Output high voltage (IOH = –2.5 mA)	3.8 V min
Output low voltage (IOL = 2.5 mA)	0.7 V max
Power on and reset state	Input

External trigger

Table 12. Digital trigger specifications

Parameter	Conditions	Specification
Trigger source (Note 7)	External digital	TRIG_IN
Trigger mode	Software-selectable	Edge sensitive: user configurable for CMOS compatible rising or falling edge.
Trigger latency		10 µs max
Trigger pulse width		1 µs min
Input high voltage		4.0 V min, 5.5 V absolute max
Input low voltage		1.0 V max, –0.5 V absolute min
Input leakage current		*±1.0 µA*

Note 7: TRIG_IN is a Schmitt trigger input protected with a 1.5 kΩ series resistor.

External clock input/output

Table 13. External clock I/O specifications

Parameter	Conditions	Specification
Pin name		SYNC
Pin type		Bidirectional
Software-selectable direction	Output (default)	Outputs internal A/D pacer clock.
	Input	Receives A/D pacer clock from external source.
Input clock rate		50 KHz, max
Clock pulse width	Input mode	1 µs min
	Output mode	5 µs min
Input leakage current	*Input mode*	*±1.0 µA*
Input high voltage		4.0 V min, 5.5 V absolute max
Input low voltage		1.0 V max, –0.5 V absolute min
Output high voltage (Note 8)	IOH = –2.5 mA	3.3 V min
	No load	3.8 V min
Output low voltage (Note 8)	IOL = 2.5 mA	1.1 V max
	No load	0.6 V max

Note 8: SYNC is a Schmitt trigger input and is over-current protected with a 1.5 kΩ series resistor.

Counter

Table 14. Counter specifications

Parameter	Specification
Pin name (Note 9)	CTR
Counter type	Event counter
Number of channels	1
Input type	TTL, rising edge triggered
Input source	*CTR screw terminal*
Resolution	32 bits
Schmidt trigger hysteresis	*20 mV to 100 mV*
Input leakage current	*±1 µA*
Input frequency	1 MHz max
High pulse width	*500 ns min*
Low pulse width	*500 ns min*
Input high voltage	4.0 V min, 5.5 V absolute max
Input low voltage	1.0 V max, –0.5 V absolute min

Note 9: CTR is a Schmitt trigger input protected with a 1.5K Ω series resistor.

Non-volatile memory

Table 15. Non-volatile memory specifications

Parameter	Specification		
EEPROM	1,024 bytes		
EEPROM Configuration	**Address Range**	**Access**	**Description**
	0x000-0x1FF	Reserved	512 bytes system and cal data
	0x200-0x3FF	Read/write	512 bytes user area

Microcontroller

Table 16. Microcontroller specifications

Parameter	Specification
Type	*High performance 8-bit RISC microcontroller*
Program Memory	*32,768 words*
Data Memory	3,936 bytes

Indicator LEDs

Table 17. Indicator LED specifications

Parameter	Specification
Power LED (top)	Indicates that the device's microcontroller has power and is configured.
Status LED	Blinks to indicate USB communications.
OEM power	OEM Connector; LED sink current up to 5 mA per LED @ 5 V_{max}

Power

Table 18. Power specifications

Parameter	Conditions	Specification
Supply current (Note 10)		80 mA
+5V$_{USER}$ power available (Note 11)	■ Connected to self-powered hub ■ Connected to externally-powered root port hub	4.0 V min, 5.25 V max
	Connected to bus-powered hub	4.0 V min, 5.25 V max
Output current (Note 12)	Connected to self-powered hub Connected to externally-powered root port hub	420 mA max
	Connected to bus-powered hub	20 mA max
Fuse F1, (F4 spare)	0452.500 – Littelfuse 0.5A NANO$^{2®}$ Slo-Blo® Subminiature Surface Mount Fuse	
Fuse F2, (F3 spare)	0452.375 – Littelfuse 0.375A NANO$^{2®}$ Slo-Blo® Subminiature Surface Mount Fuse	

Note 10: This is the total current requirement for the USB-7204 which includes up to 10 mA for the status LED.

Note 11: *Self-powered hub* refers to a USB hub with an external power supply. Self-powered hubs allow a connected USB device to draw up to 500 mA.

Root port hubs reside in the computer's USB host controller. The USB port(s) on your computer are root port hubs. All externally powered root port hubs (desktop computers) provide up to 500 mA of current for a USB device. Battery-powered root port hubs provide 100 mA or 500 mA, depending upon the manufacturer. A laptop computer that is not connected to an external power adapter is an example of a battery-powered root port hub.

Bus powered hubs receive power from a self-powered or root port hub. In this case the max current available from the USB +5 V is 100 mA. The minimum USB +5 V voltage level can be as low as 4.1 V.

Protected by fuse F2 at 375 mA.

Note 12: This refers to the total amount of current that can be sourced from the USB +5 V, analog outputs and digital outputs.

General

Table 19. General specifications

Parameter	Specification	
Device type	USB 2.0 (full-speed)	
Device compatibility	USB 1.1, USB 2.0	
DEFAULTS for programmable options and "DEV:RESET/DEFAULT" message	AI	Channel Mode = Differential Range = ±10 V
	AInScan	Low Channel = 0 High Channel = 0 Samples = 1000 Rate = 1000 Range = ±10 V Pacer = Master Transfer Mode = BlockIO Trigger = Disabled Queue = Disabled Status = Idle
	AITrig	Trigger Polarity = Rising Rearm – Disabled
	AOutScan	Low Channel = 0 High Channel = 0 Samples = 1000 Rate = 1000 Trigger = Disabled Status = Idle
	CTR	Value = 0

Environmental

Table 20. Environmental specifications

Parameter	Specification
Operating temperature range	0 °C to 70 °C
Storage temperature range	–40 °C to 70 °C
Humidity	0% to 90% non-condensing

Mechanical

Table 21. Mechanical specifications

Parameter	Specification
Dimensions (L × W × H)	90.17 × 95.25 × 12.70 mm (3.55 × 3.75 × 0.5 in.) 111.76 mm (4.40 in.) length with detachable screw terminals connected
USB cable length	*3 m (9.84 ft) max*
User connection length	*3 m (9.84 ft) max*

Screw terminal connector and pinout

Table 22. Connector specifications

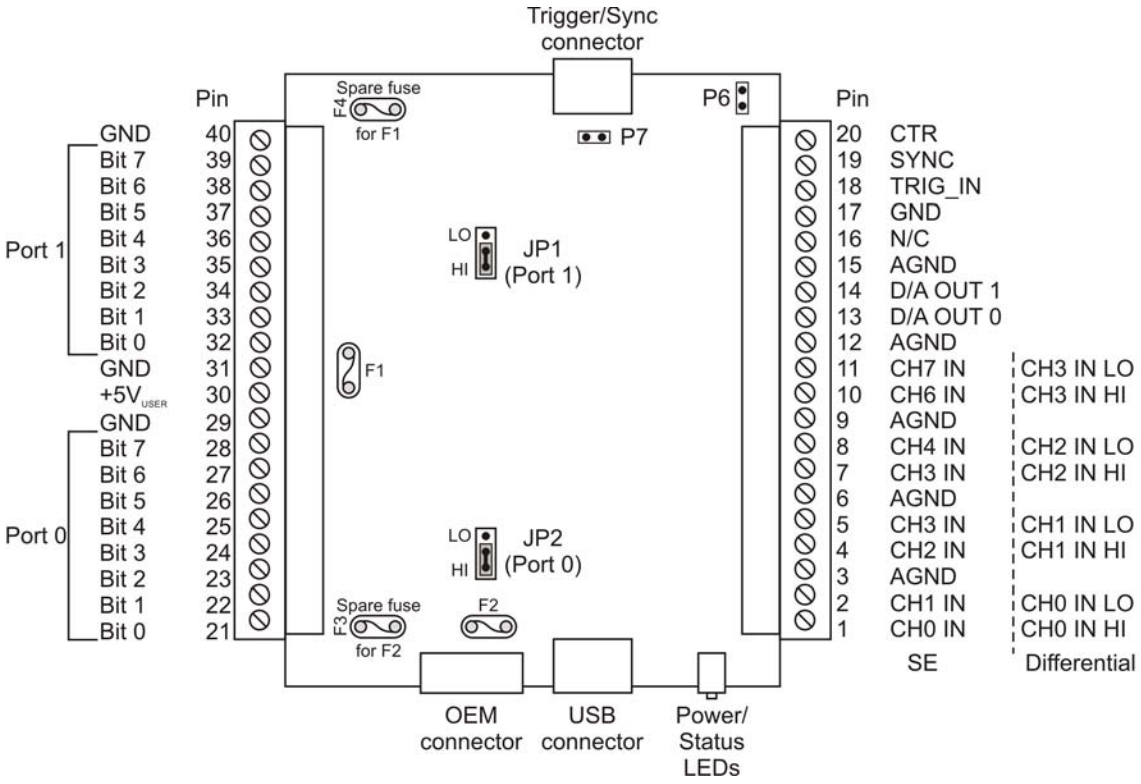
Parameter	Specification
Connector type	Screw terminal
Wire gauge range	16 AWG to 30 AWG

Table 23. Differential mode pinout

Pin	Signal Name	Pin	Signal Name
1	CH0 IN HI	21	Port 0 Bit 0
2	CH0 IN LO	22	Port 0 Bit 1
3	AGND	23	Port 0 Bit 2
4	CH1 IN HI	24	Port 0 Bit 3
5	CH1 IN LO	25	Port 0 Bit 4
6	AGND	26	Port 0 Bit 5
7	CH2 IN HI	27	Port 0 Bit 6
8	CH2 IN LO	28	Port 0 Bit 7
9	AGND	29	GND
10	CH3 IN HI	30	$+5V_{USER}$
11	CH3 IN LO	31	GND
12	AGND	32	Port 1 Bit 0
13	D/A OUT 0	33	Port 1 Bit 1
14	D/A OUT 1	34	Port 1 Bit 2
15	AGND	35	Port 1 Bit 3
16	N/C (no connect)	36	Port 1 Bit 4
17	GND	37	Port 1 Bit 5
18	TRIG_IN	38	Port 1 Bit 6
19	SYNC	39	Port 1 Bit 7
20	CTR	40	GND

Table 24. Single-ended mode pinout

Pin	Signal Name	Pin	Signal Name
1	CH0 IN	21	Port 0 Bit 0
2	CH1 IN	22	Port 0 Bit 1
3	AGND	23	Port 0 Bit 2
4	CH2 IN	24	Port 0 Bit 3
5	CH3 IN	25	Port 0 Bit 4
6	AGND	26	Port 0 Bit 5
7	CH4 IN	27	Port 0 Bit 6
8	CH5 IN	28	Port 0 Bit 7
9	AGND	29	GND
10	CH6 IN	30	$+5V_{USER}$
11	CH7 IN	31	GND
12	AGND	32	Port 1 Bit 0
13	D/A OUT 0	33	Port 1 Bit 1
14	D/A OUT 1	34	Port 1 Bit 2
15	AGND	35	Port 1 Bit 3
16	N/C (no connect)	36	Port 1 Bit 4
17	GND	37	Port 1 Bit 5
18	TRIG_IN	38	Port 1 Bit 6
19	SYNC	39	Port 1 Bit 7
20	CTR	40	GND



OEM connector and pinout (P4)

Table 25. OEM connector specifications

Parameter	Specification
Connector type	10 position 2.54 mm (0.1 in.) box header

Table 26. OEM connector pinout

Pin	Signal Name	Pin	Signal Name
1	N/C	2	V_{BUS} (fuse protected)
3	N/C	4	D–
5	N/C (do not connect anything to this pin)	6	D+
7	N/C (do not connect anything to this pin)	8	GND
9	N/C (do not connect anything to this pin)	10	SHIELD

Trigger/Sync connector and pinout (P5)

Table 27. Trigger/Sync connector specifications

Parameter	Specification
Connector type	10 position 2.54 mm (0.1 in.) box header

Table 28. Trigger/Sync connector pinout

Pin	Signal Name	Pin	Signal Name
1	TRIG_IN	2	GND
3	N/C	4	GND
5	SYNC	6	GND
7	N/C	8	GND
9	N/C	10	N/C

CE Declaration of Conformity

Manufacturer: Measurement Computing Corporation
Address: 10 Commerce Way
Suite 1008
Norton, MA 02766
USA

Category: Electrical equipment for measurement, control and laboratory use.

Measurement Computing Corporation declares under sole responsibility that the product

USB-7204

to which this declaration relates is in conformity with the relevant provisions of the following standards or other documents:

EC EMC Directive 2004/108/EC: General Requirements, EN 61326-1:2006 (IEC 61326-1:2005).

Emissions:

- EN 55011 (2007) / CISPR 11(2003): Radiated emissions: Group 1, Class A
- EN 55011 (2007) / CISPR 11(2003): Conducted emissions: Group 1, Class A

Immunity: EN 61326-1:2006, Table 3.

- IEC 61000-4-2 (2001): Electrostatic Discharge immunity.
- IEC 61000-4-3 (2002): Radiated Electromagnetic Field immunity.
-
- To maintain compliance to the standards of this declaration, the following conditions must be met.
-
- The host computer, peripheral equipment, power sources, and expansion hardware must be CE compliant.
- All I/O cables must be shielded, with the shields connected to ground.
- I/O cables must be less than 3 meters (9.75 feet) in length.
- The host computer or embedded system must be properly grounded.
- Equipment must be operated in a controlled electromagnetic environment as defined by Standards EN 61326-1:2006, or IEC 61326-1:2005.
-

Declaration of Conformity based on tests conducted by Chomerics Test Services, Woburn, MA 01801, USA in August, 2004. Test records are outlined in Chomerics Test Report #EMI3948.04. Further testing was conducted by Chomerics Test Services, Woburn, MA. 01801, USA in December, 2008. Test records are outlined in Chomerics Test report #EMI5216.08.

We hereby declare that the equipment specified conforms to the above Directives and Standards.

Carl Haapaoja, Director of Quality Assurance

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